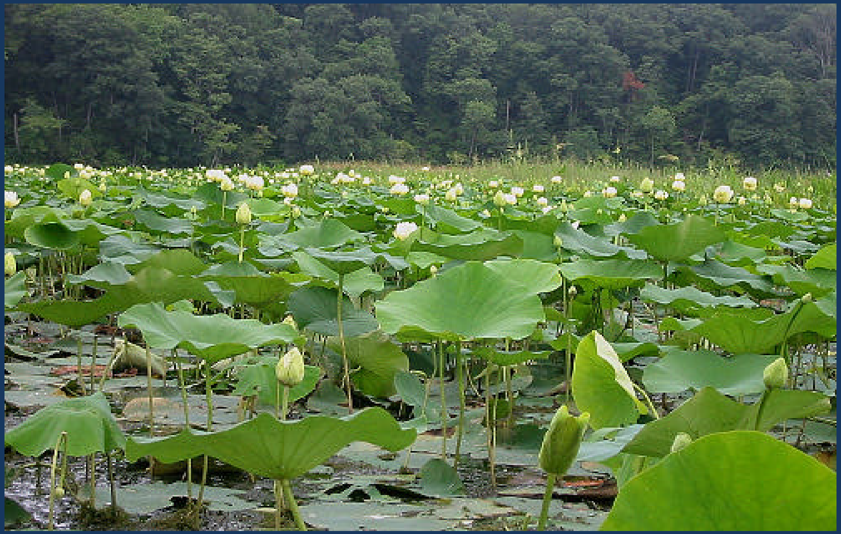
Bacteria Total Maximum Daily Load Studies for Tributaries to the Potomac River



Technical Advisory Committee Meeting
March 1, 2011

Meeting Agenda

I. Introductions
II. TMDL Background Information
III. Technical Approach
IV. Next Steps
V. Questions

TMDL Background Information

Why are we here?

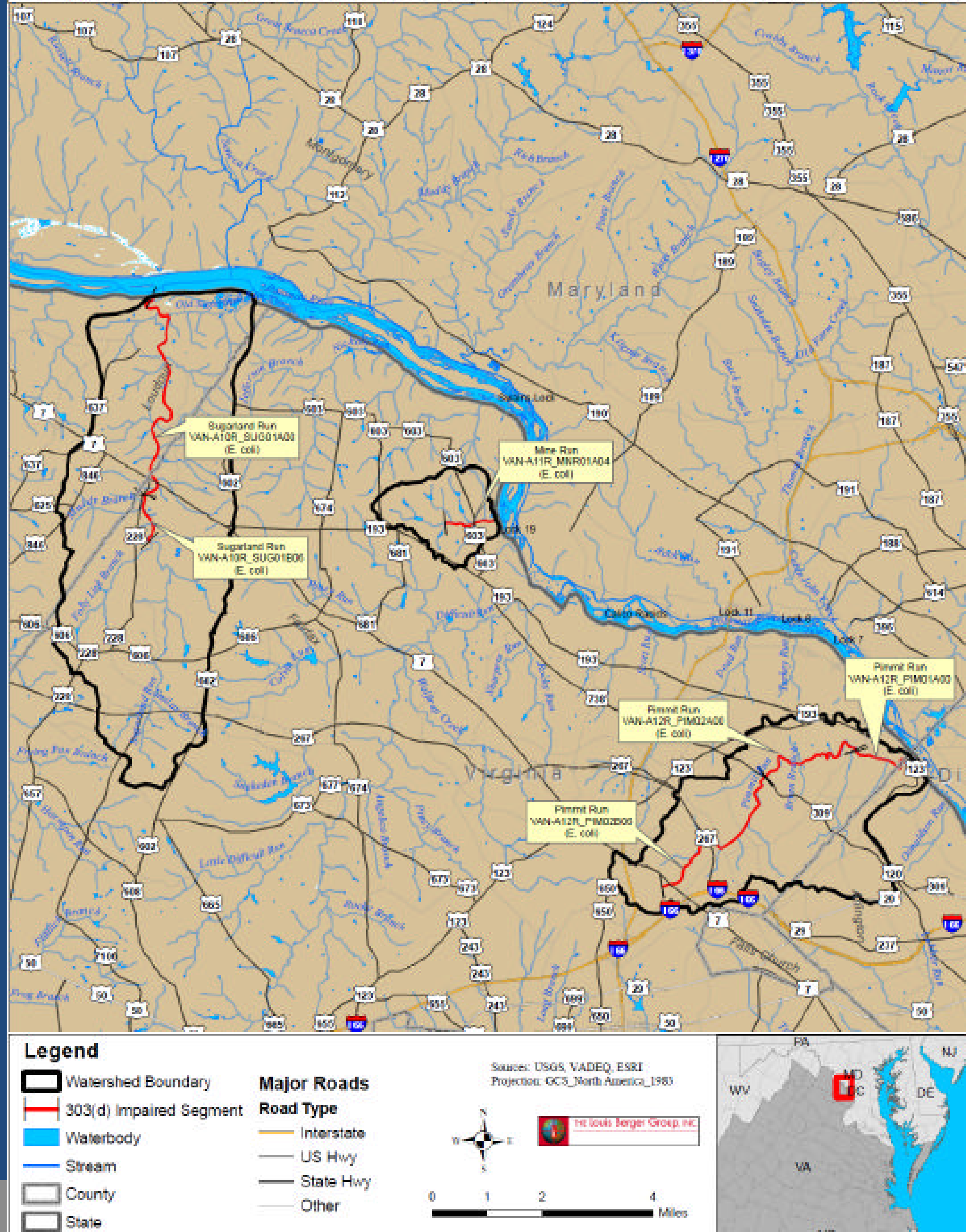
Portions of several tributaries to the Potomac River do not meet water quality standards.

- Which tributaries are included in this study?
- How do we know the standards aren't being met?
- Why aren't the standards being met?
- What is being done to correct the problem?
- Who is involved in this process?

Which tributaries are included?

- Sugarland Run
- Mine Run
- Pimmit Run
- Powells Creek
- Quantico Creek
- South Fork Quantico Creek
- Little Creek
- Chopawamsic Creek
- North Branch Chopawamsic Creek
- Aquia Creek
- Austin Run
- Accokeek Creek
- Potomac Creek
- Potomac Run
- Unnamed Tributary to the Potomac River

303 (d) Impaired Segment Watershed Areas: Sugarland Run, Mine Run, Pimmit Run



303(d) Impaired Segment Watersheds: Powells Creek, Quantico Creek, South Fork Quantico Creek, Little Creek, Chopawamsic Creek, North Branch Chopawamsic Creek, Aquia Creek, Austin Run, Accokeek Creek, Potomac Creek, Potomac Run, Unnamed Tributary to Potomac River

Waterbody Name *Location*	**Segment Size**	**Cause**	**Upstream Limit**	**Downstream Limit**	**DEQ Monitoring Station(s)** *Station Location*	**Year First Listed as Impaired**	**2010 Exceedance Rate**
Sugarland Run *Fairfax County* *Loudoun County* *Town of Herndon*	0.95 miles	*E. coli*	Confluence with Folly Lick Branch	Boundary of the PWS designation area, at rivermile 4.82	**1aSUG004.42** *Route 7 Bridge Crossing*	2006	5 of 28 samples (17.9%)
	4.77 miles	*E. coli*	Boundary of the PWS designation area, at rivermile 4.82	Confluence with the Potomac River	**1aSUG004.42** *Route 7 Bridge Crossing*	2002	5 of 28 samples (17.9%)
Mine Run *Fairfax County*	0.93 miles	*E. coli*	Confluence with an unnamed tributary to Mine Run	Confluence with the Potomac River	**1aMNR000.72** Route 603 Bridge Crossing	2006	3 of 12 samples (25.0%)
Pimmit Run *Arlington County* *Fairfax County*	1.62 miles	*E. coli*	Confluence with Little Pimmit Run	Confluence with the Potomac River	**1aPIM000.15** *Route 120 (Glebe Road) Bridge Crossing*	2010*	3 of 11 samples (27.3%)
	2.46 miles	*E. coli*	Route 309 bridge crossing	Confluence with Little Pimmit Run	**1aPIM001.89** *Ranleigh Road Bridge Crossing*	2010*	3 of 14 samples (21.4%)
	3.29 miles	*E. coli*	Headwaters of Pimmit Run	Route 309 bridge crossing	**1aPIM004.16** *Route 309 Bridge Crossing*	2010*	4 of 10 samples (40.0%)

** Pimmit Run was originally listed with a fecal coliform bacteria impairment from 2002 to 2008. 2010 was the first assessment cycle where Pimmit Run was listed as impaired for E. coli.*

Waterbody Name *Location*	**Segment Size**	**Cause**	**Upstream Limit**	**Downstream Limit**	**DEQ Monitoring Station(s)** *Station Location*	**Year First Listed as Impaired**	**2010 Exceedance Rate**
Powells Creek *Prince William County*	4.62 miles	*E. coli*	0.2 rivermiles below Lake Montclair	End of the free-flowing waters	**1aPOW006.11** *Northgate Drive Bridge Crossing*	2006	2 of 13 samples (15.4%)
Quantico Creek *Prince William County* *Town of Dumfries*	1.45 miles	*E. coli*	Confluence with South Fork Quantico Creek	Start of the tidal waters of Quantico Bay.	**1aQUA004.46** *Route 1 Bridge Crossing*	2006	7 of 27 samples (25.9%)
South Fork Quantico Creek *Prince William County* *Town of Dumfries*	4.63 miles	*E. coli*	Headwaters of the South Fork Quantico Creek	Start of the impounded waters	**USGS Station 01658500**	2004	7 of 47 samples (14.9%)
Little Creek *Prince William County*	3.78 miles	*E. coli*	Headwaters of Little Creek	Confluence with the Potomac River	**1aLIE000.52** *Geiger Road Bridge Crossing*	2006	7 of 15 samples (46.7%)
Chopawamsic Creek *Stafford County* *Prince William County*	0.1143 mi^2	Fecal Coliform	Upstream boundary of tidal waters	0.5 rivermile downstream of monitoring station 1aCHO003.65	**1aCHO003.65** *Route 1 Bridge Crossing*	2004	4 of 36 samples (11.1%)
North Branch Chopawamsic Creek *Stafford County* *Prince William County*	6.9 miles	*E. coli*	Headwaters of North Branch Chopawamsic Creek	Confluence with Middle Branch	**USGS Station 01659000**	2004	2 of 17 samples (11.7%)
Unnamed Tributary to the Potomac River *Stafford County*	2.9 miles	*E. coli*	Headwaters of the unnamed tributary	Confluence with the Potomac River	**1aXLF000.13** *Route 633 Bridge Crossing*	2010	2 of 11 samples (18.2%)

Waterbody Name *Location*	Segment Size	Cause	Upstream Limit	Downstream Limit	DEQ Monitoring Station(s) *Station Location*	Year First Listed as Impaired	2010 Exceedance Rate
Aquia Creek *Fauquier County Stafford County*	6.47 miles	*E. coli*	Confluence with Cannon Creek	Smith Lake (Aquia Reservoir).	**1aAUA014.51** *Route 641 Bridge Crossing*	2006*	3 of 27 samples (11.1%)
	0.3638 mi^2	Enterococcus	Rivermile 4.28	Rivermile 3.28	**1aAUA003.71** *Railroad Bridge Crossing*	2008	5 of 38 samples (13.2%)
Austin Run *Fauquier County Stafford County*	0.79 miles	Fecal Coliform	Confluence with an unnamed tributary (streamcode XGQ)	Confluence with Aquia Creek	**1aAUS000.49** *End of Aquia Drive*	2004	3 of 8 samples (37.5%)
Accokeek Creek *Stafford County*	4.21 miles	*E. coli*	Confluence with an unnamed tributary	End of the free-flowing waters	**1aACC006.13** *Route 608 Bridge Crossing*	2006**	4 of 23 samples (17.4%)
Potomac Creek *Stafford County*	2.18 miles	*E. coli*	Railroad crossing at the west end of swamp, upstream from Route 608	Downstream until the east end of swamp	**1aPOM006.72** Route 608 Bridge Crossing	2006*	4 of 13 samples (30.8%)
	3.66 miles	*E. coli*	Outlet of Abel Lake	Confluence with an unnamed tributary to Potomac Creek, at rivermile 9.12	**1aPOM012.24** Route 627 Bridge Crossing	2006	2 of 13 samples (15.4%)
Potomac Run *Stafford County*	6.13 miles	*E. coli*	Headwaters of Potomac Run	Confluence with Long Branch	**1aPOR000.40** (Route 648 Bridge Crossing)	2006	10 of 13 samples (76.9%)

* *Aquia Creek and Potomac Creek were originally listed with fecal coliform bacteria impairments in 2004. 2006 was the first assessment cycle where both streams were listed as impaired for E. coli.*

** *Accokeek Creek was originally listed with a fecal coliform bacteria impairment in 2002. 2006 was the first assessment cycle where Accokeek Creek was listed as impaired for E. coli.*

How do we know if water bodies in Virginia are healthy?

- Perform physical and chemical monitoring on water bodies throughout the state.
- Monitor parameters such as:
  - pH
  - Temperature
  - Dissolved Oxygen
  - Biological Community
  - Bacteria
  - Nutrients
  - Fish Tissues
  - Metals/Toxic Pollutants

What does DEQ do with the monitoring data that is collected?

Compare the data collected to the water quality standards.

Water Quality Standards:

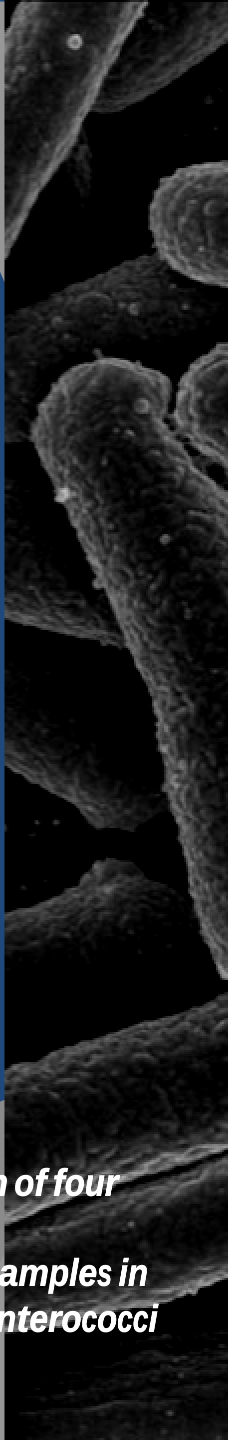
- Regulations based on federal and state law.
- Set numeric and narrative limits on pollutants.
- Consist of designated use(s) and water quality criteria to protect the designated uses.

Designated Uses

- Recreational
- Public Water Supply
- Wildlife
- Fish Consumption
- Shellfish
- Aquatic Life

The attainment of the recreational use is evaluated by testing for the presence of *E. coli* bacteria in freshwater systems and enterococci bacteria in transitional and salt waters.

Recreational Use Impairment:
Fecal Coliform, *E. coli* and Enterococci Bacteria



Fecal Coliform:

- Found in the digestive tract of humans and warm blooded animals
- Indicator of the potential presence of pathogens in water bodies

Escherichia coli:

- Subset of fecal coliform bacteria
- Correlate better with swimming associated illness in freshwater

Enterococci:

- Subset of fecal streptococcus bacteria
- Indicator used for determining recreational risks in salt or transitional waters

Indicator	Geometric Mean
E. Coli (Freshwater)	126
Enterococci (Transitional and Saltwater)	35

- *Geometric Means are calculated using all data collected during any calendar month with a minimum of four weekly samples.*
- *If there are insufficient data to calculate a monthly geometric mean, no more than 10% of the total samples in the assessment period should exceed 235 cfu/100 ml of E. coli in freshwater, and 104 cfu/100 ml of enterococci in transitional and saltwater.*

Potential Sources of Fecal Coliform, *E. coli* and Enterococci Bacteria

What happens when a water body doesn’t meet water quality standards?

- Waterbody is listed as “impaired” and placed on the 303(d) list.
- Once a water body is listed as impaired, a Total Maximum Daily Load value must be developed for that impaired stream segment to address the designated use impairment.
- TMDL Studies are required by law:
  - 1972 Clean Water Act (CWA)
  - 1997 Water Quality Monitoring Information and Restoration Act (WQMIRA)

What is a TMDL ?
Total Maximum Daily Load

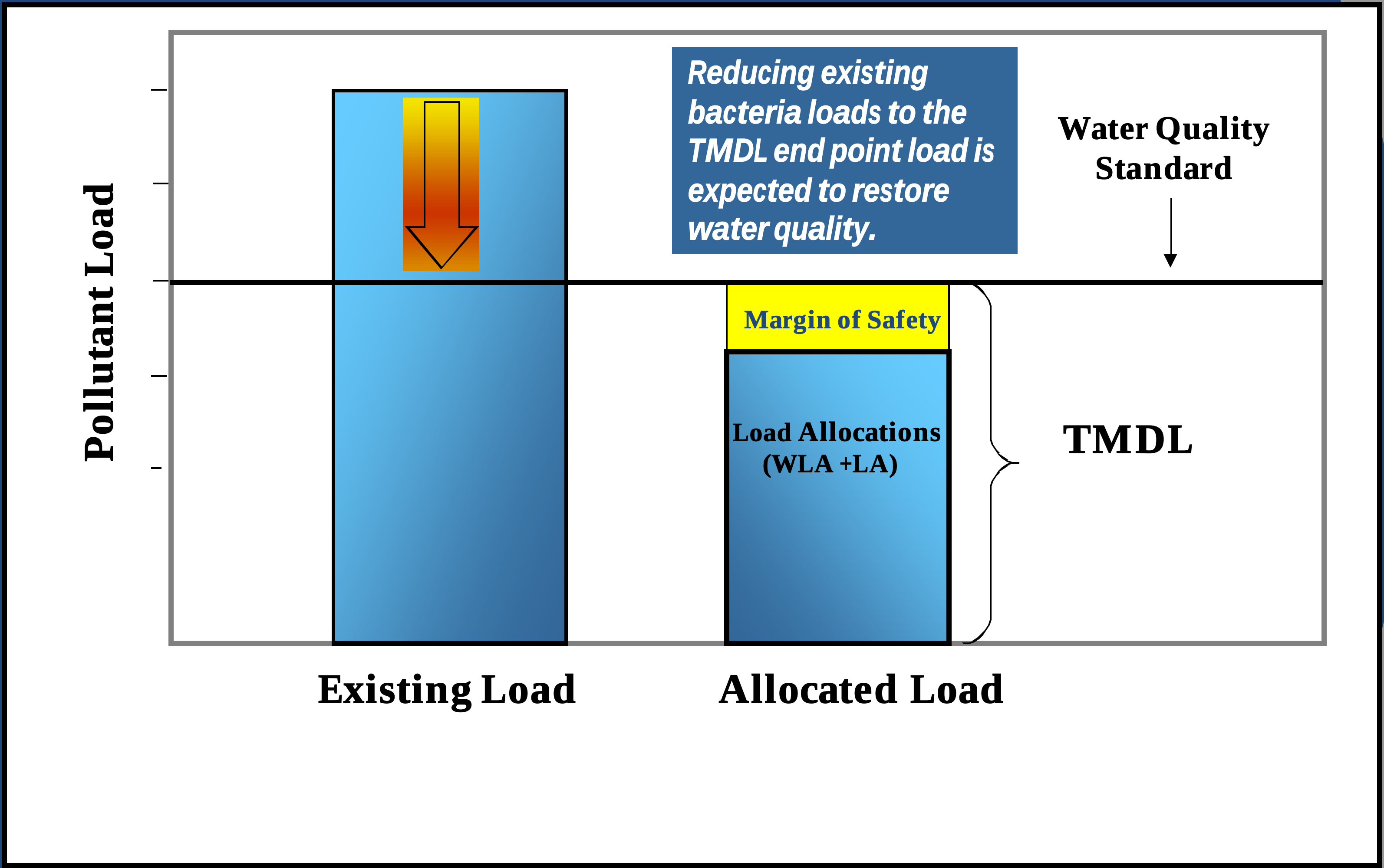
TMDL = Sum of WLA + Sum of LA + MOS

Where:

TMDL	=	Total Maximum Daily Load
WLA	=	Waste Load Allocation (point sources)
LA	=	Load Allocation (nonpoint sources)
MOS	=	Margin of Safety

A TMDL is the maximum amount of a pollutant a water body can receive and still meet water quality standards.

An Example TMDL



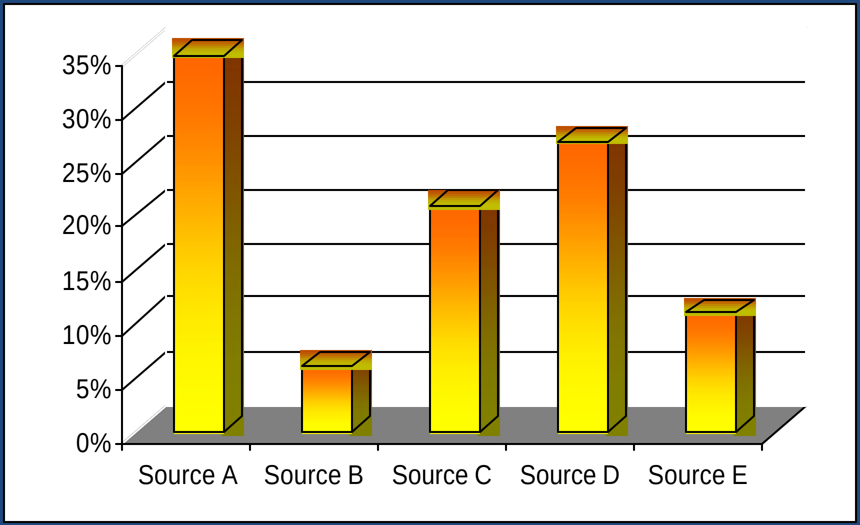
Required Elements of a TMDL

A TMDL must:

- Be developed to meet Water Quality Standards
- Be developed for critical stream conditions
- Consider seasonal variations
- Consider impacts of background contributions
- Include wasteload and load allocations (WLA, LA)
- Include a margin of safety (MOS)
- Be subject to public participation
- Provide reasonable assurance of implementation

TMDL Development Methodology

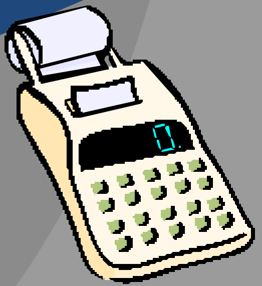
1. Identify all sources of a given pollutant within the watershed.



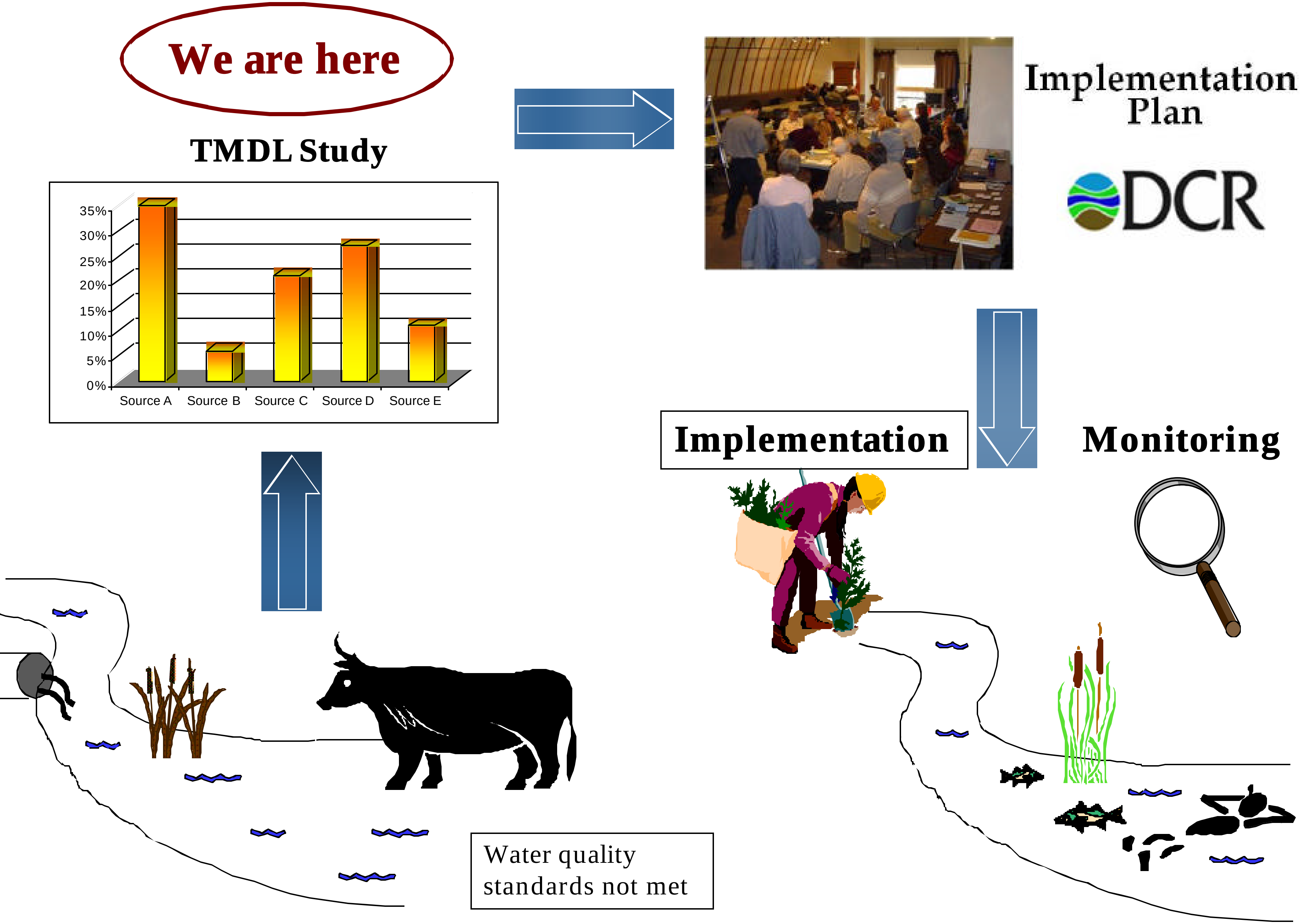
2. Calculate the amount of pollutant entering the stream from each source type.

3. Enter available data into a computer model. Model simulates pollutant loadings into the watershed.

4. Use the model to calculate the pollutant reductions needed, by source, to attain Water Quality Standards.



5. Allocate the allowable loading to each source and include a margin of safety.


We are here
TMDL Study
35%
30%
25%
20%
15%
10%
5%
0%
Source A
Source B
Source C
Source D
Source E
Implementation Plan
DCR
Implementation
Monitoring
Water quality standards not met

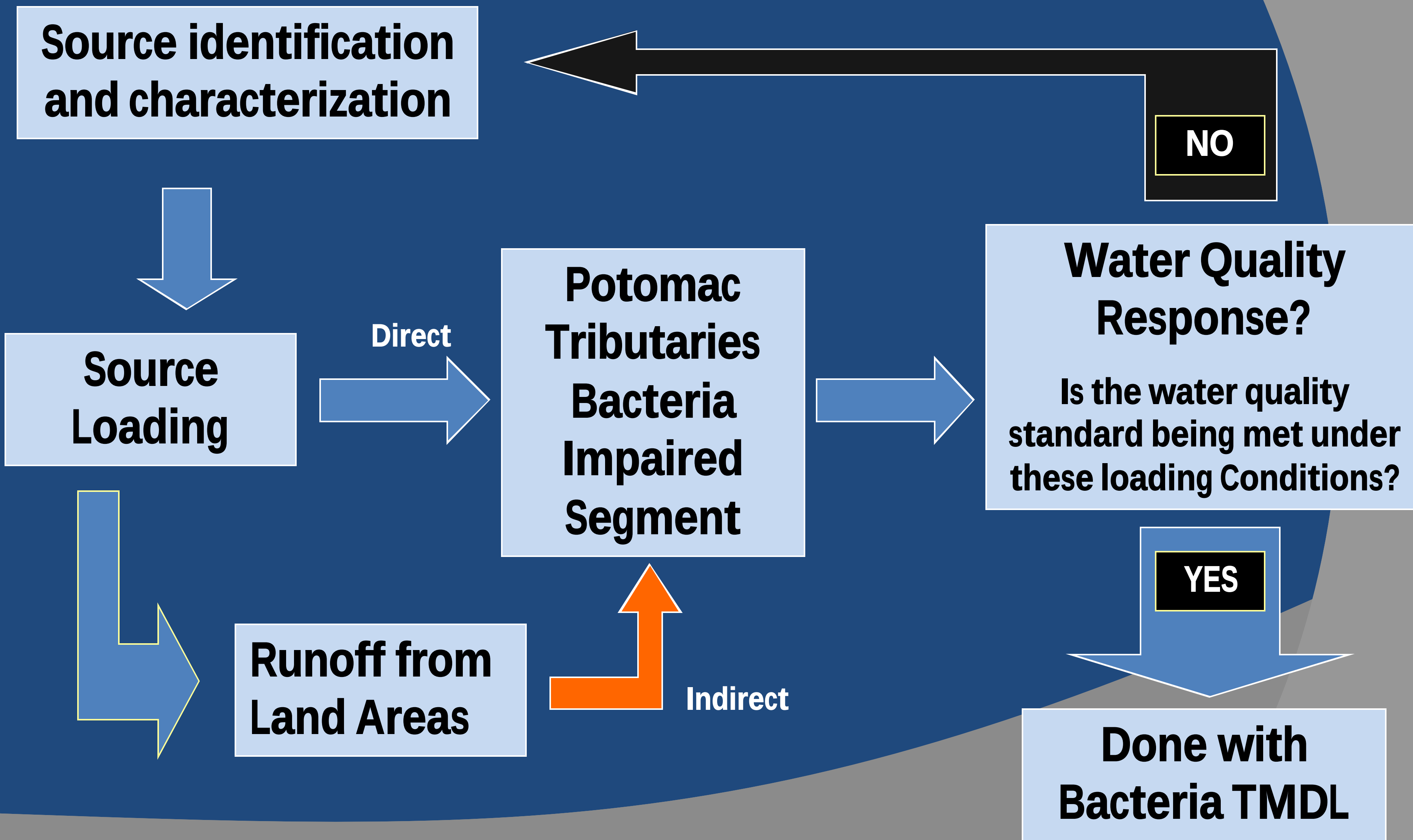
Who is involved in this process?

DEQ :	Lead Agency for TMDL Development
DCR :	Partners with DEQ in TMDL Development, Lead Agency for TMDL IP Development
Contractor:	Performs Modeling for TMDL Development (for this project, contractor is the Louis Berger Group).
TAC:	Representatives from state and local governments, watershed groups, planning district commission, soil and water conservation districts, etc. Provides technical input and information for TMDL development.
Citizens:	Any citizen who wishes to participate in the project; provide local knowledge and information.

Technical Approach for TMDL Development

- Preliminary Technical Approach
- Data used in the TMDL
- Bacteria Sources Inventory and Assessment

Bacteria TMDL Development Process



Preliminary Technical Approach

- **Bacteria Source Assessment**
  - Identify and assess all potential sources of bacteria in the selected Potomac tributaries
- **EPA Bacterial Indicator Tool**
  - Input local population estimates for wildlife, livestock, pets, etc.
  - Estimate bacteria contribution from multiple sources (livestock, pets, wildlife) and direct input of bacteria to streams from grazing livestock and failing septic systems
  - Estimate daily accumulated bacteria load per acre for each source
  - Estimate the distribution of the daily accumulated bacteria load
- **Water Quality Model: Hydrologic Simulation Program Fortran (HSPF)**
  - Estimate existing and target instream bacteria loads
- **Link HSPF to Simplified Volumetric Tidal Model (only for tidally influenced impaired streams)**
- **Develop TMDL Allocations**

Technical Approach (continuation)

- HSPF
  - Hydrologic, watershed-based instream water quality model
  - Explicitly accounts for the specific watershed conditions, the seasonal variations in rainfall and climate conditions, and activities and uses related to bacteria loading
  - Runoff portion of the model will be used to generate the NPS loads within each impaired watershed
  - Incorporates point and non-point sources

- Simplified Volumetric Tidal Model
  - Uses a mass balance approach over a tidal period (~12 hrs)
  - Assumes a completely mixed system (no density, concentration, and volume variations)
  - Used for small watersheds and estuaries
  - Incorporates point and non-point sources
  - Time independent (steady state)

Technical Approach (continuation)

Hydrologic Simulation Program Fortran

Input → **Model** → **Output**

Factors:

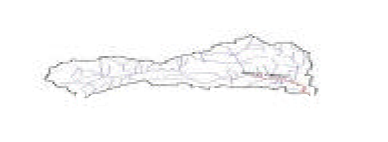
Bacteria loads from point sources

Rainfall events

Bacteria build up

Bacteria wash off

Bacteria die off rates



Land use

River Response

Technical Approach

Simplified Volumetric Tidal Model

Input

Maximum bacteria concentration in the estuary

Maximum bacteria concentration at boundary at the mouth of the estuary

Volumes of water at sea level , entering the bay, flowing out of the bay, and net freshwater

Total daily bacteria die off rate

Model

Simplified Volumetric Tidal Model

Time Independent

Mass balance approach over a tidal period (~12 hrs)

Completely mixed system (no density, concentration, and volume variations)

Output

Total Bacteria Load Capacity in the Impaired Estuary

- Existing Load
- Allocated Load

Data used in the TMDL

- **Watershed Physiographic Data:**
  - Land use distribution: National Land Coverage Data (NLCD) 2006
  - To identify accumulated bacteria loads by land use (EPA Bacterial Indicator Tool, HSPF)
- **Hydrographic and Climatologic Data**
  - Observed continuous precipitation and flow, tidal range, bathymetry data
  - To calibrate flow in HSPF and set up the tidal model
- **Potential Pollutant Sources:**
  - Permitted point sources and direct discharges (Permit data and information, Discharge monitoring reports (DMR)), Septic Systems and Straight Pipes, Livestock, Wildlife, and Pets
  - To estimate existing accumulated bacteria loads from each source using the EPA Bacterial Indicator Tool and then to estimate instream bacteria pollutants using HSPF
- **Water Quality Monitoring Data (VA DEQ and USGS)**
  - To calibrate the HSPF Model using observed bacteria data

Bacteria Sources Inventory and Assessment

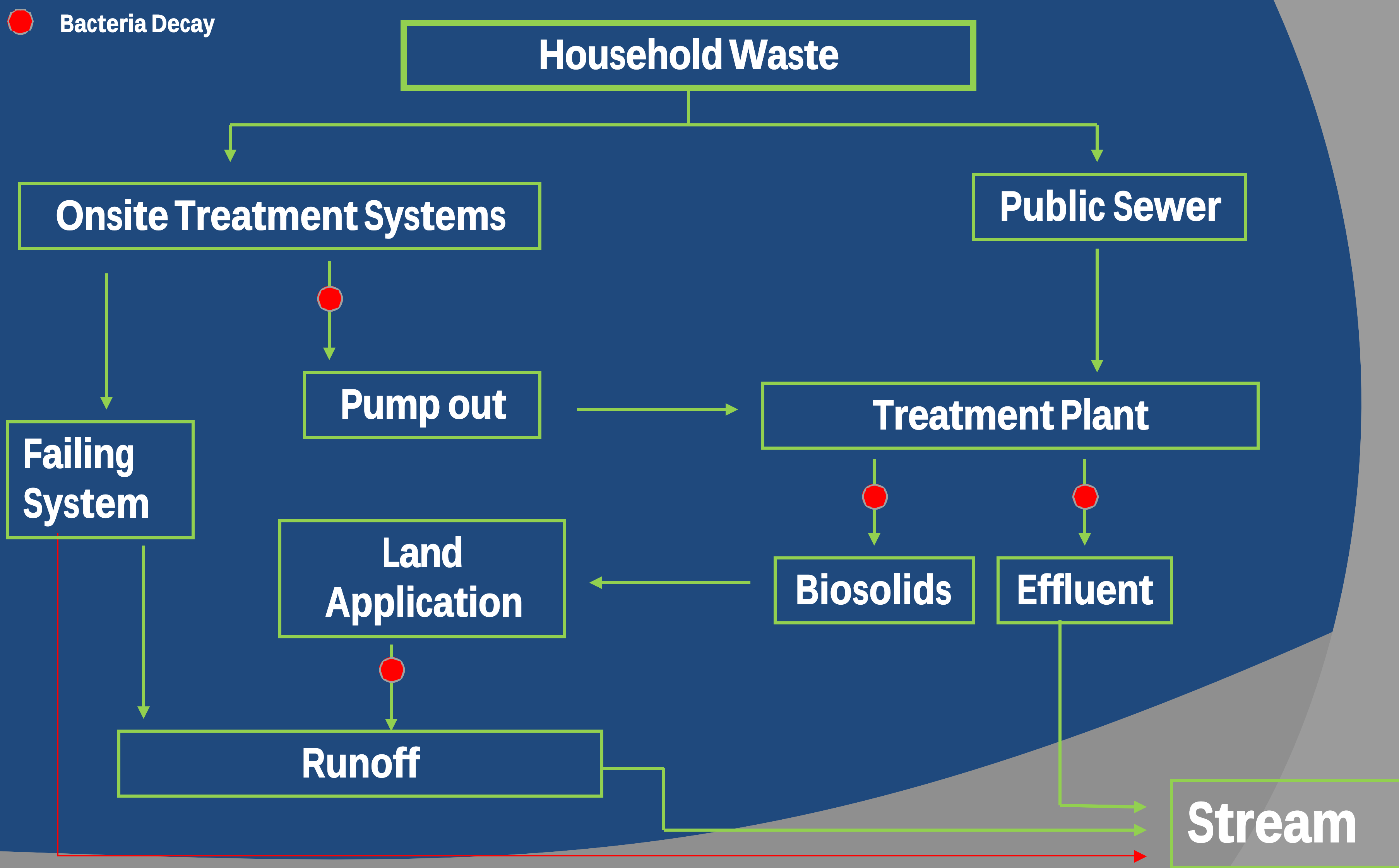
- Bacteria loading from <u>Human Sources</u>
  - Public Sewer and Straight pipes (1990 Census Data)
  - Septic systems (local VDH health districts)
  - Biosolids, when applied improperly (VA DEQ)

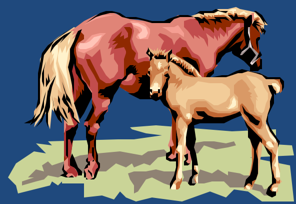
- Bacteria loading from <u>Livestock</u>
  - Livestock inventory (2007 Agricultural Census Data)
  - Livestock grazing and stream access
  - Confined animal facilities
  - Manure management

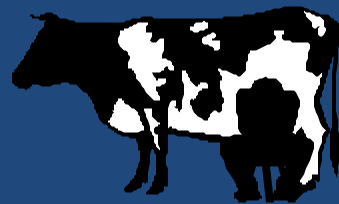
- Bacteria loading from <u>Wildlife</u> (VDGIF)
  - Wildlife Inventories

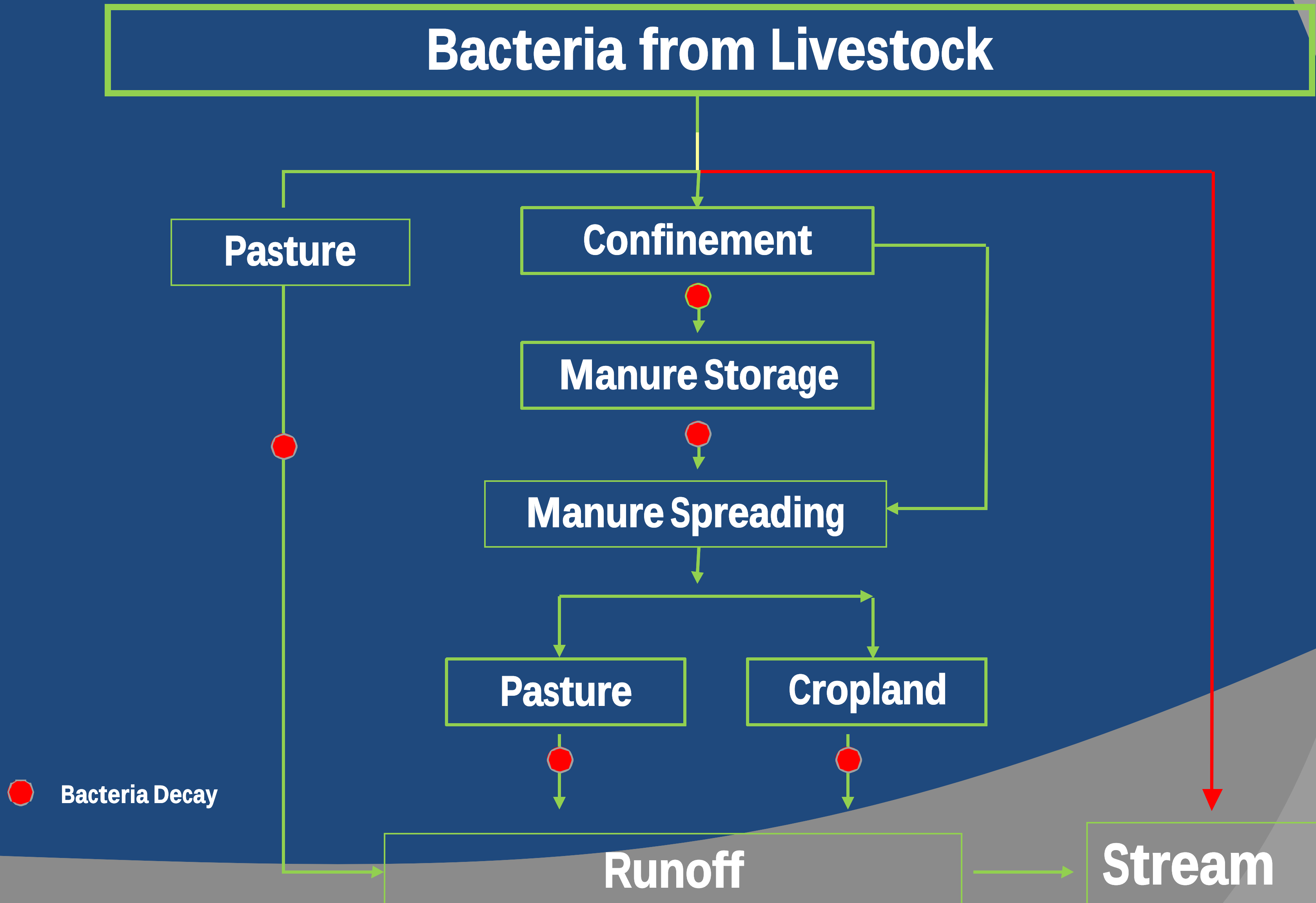
- Bacteria loading from <u>Pets</u> (Census Data 2009, American Veterinary Medical Association (AVMA))
  - Pet Inventories

Bacteria from Human Sources

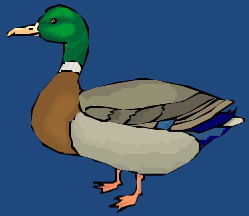


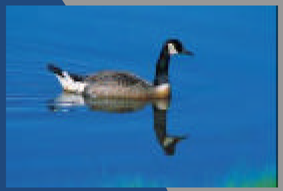
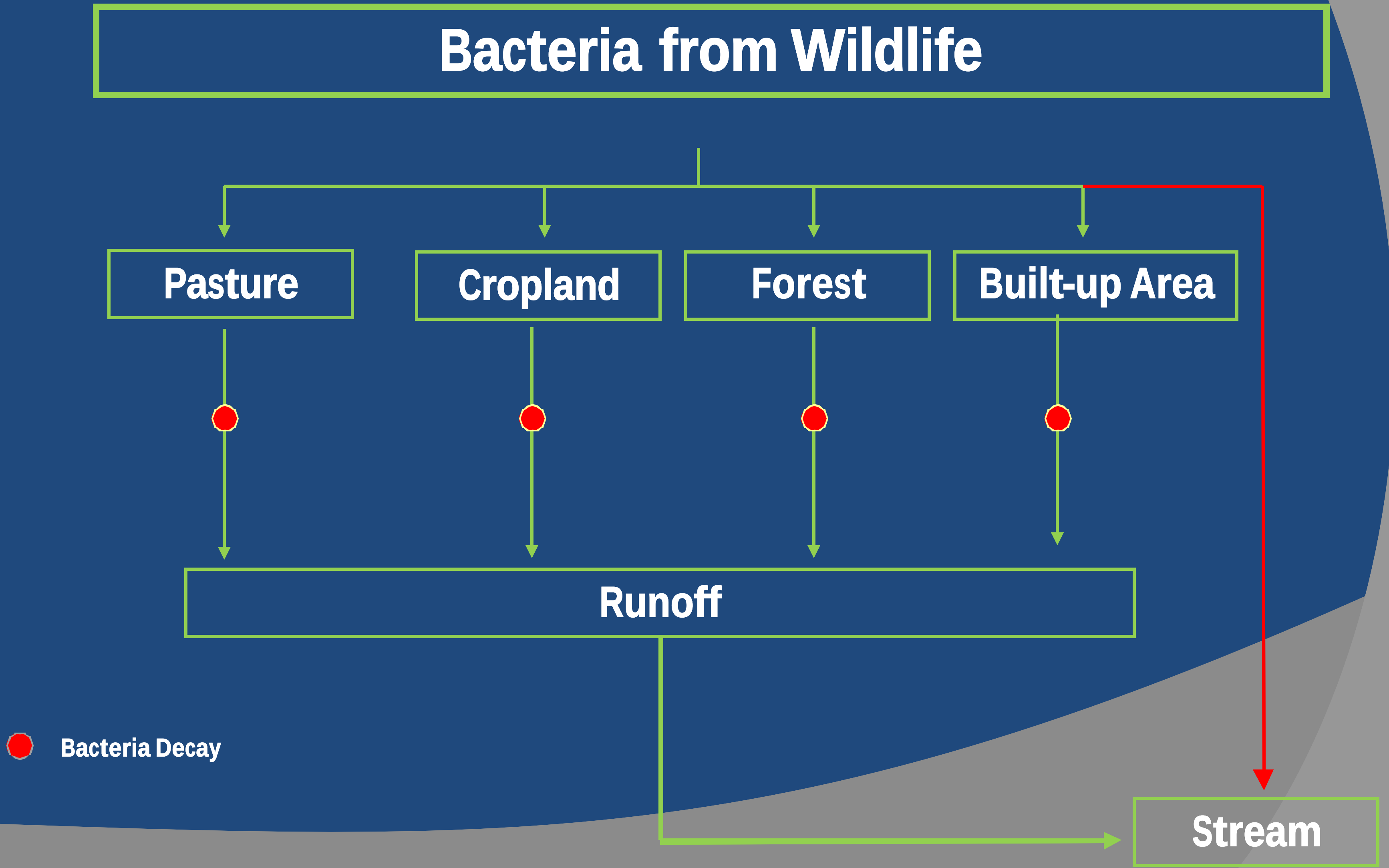


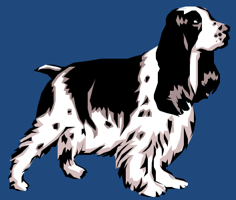



Bacteria from Livestock
Pasture
Confinement
Manure Storage
Manure Spreading
Pasture
Cropland
Bacteria Decay
Runoff
Stream

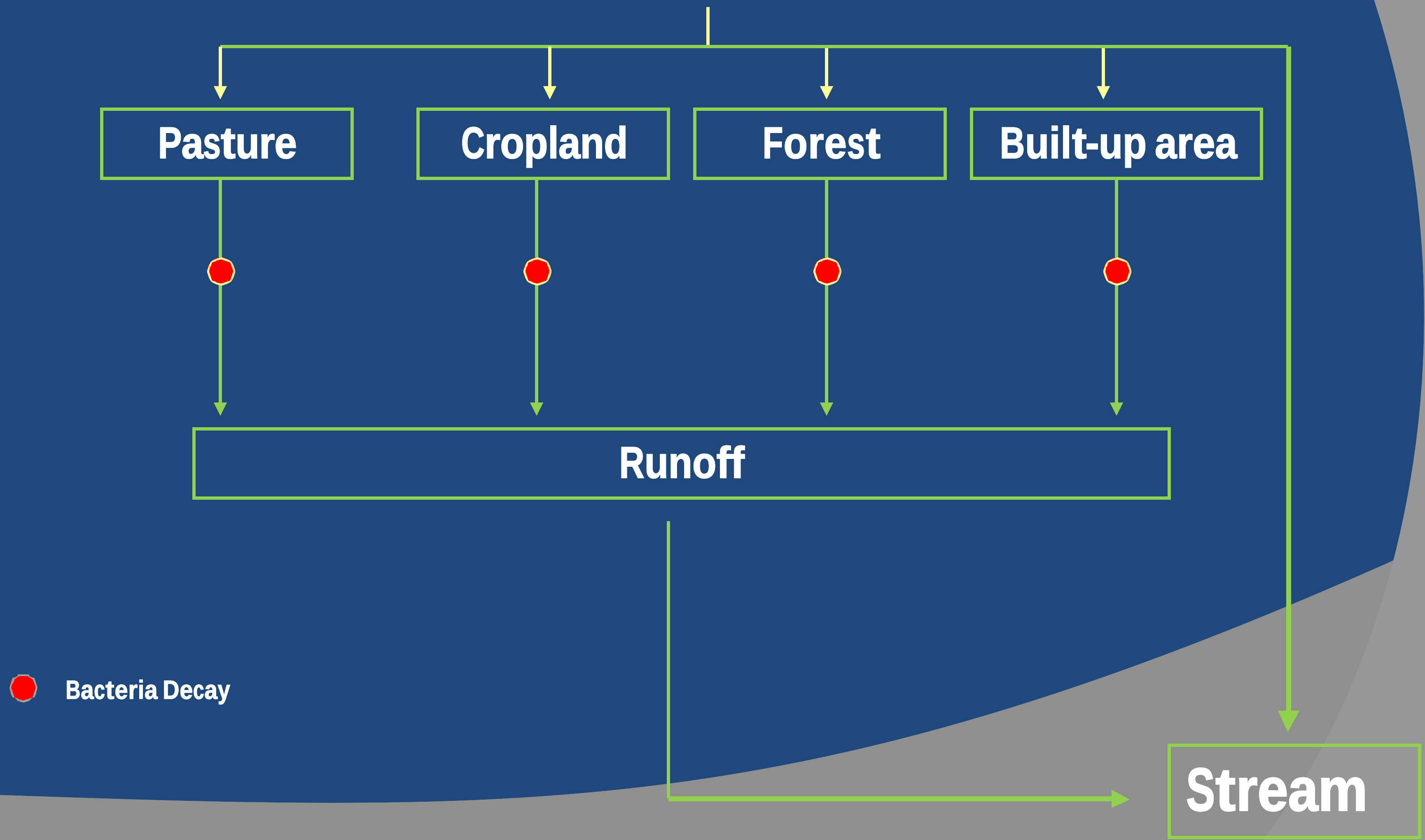






Bacteria from Wildlife
Pasture
Cropland
Forest
Built-up Area
Runoff
Stream
Bacteria Decay



Bacteria from Pets (Cats & Dogs)



Source Loading Estimates

- Determine the daily fecal coliform production by source
- Determine whether the source is
  - Direct Source
  - Indirect Source
- Calculate the load to each land use based on a monthly basis and for each source
- Estimate bacteria load used in HSPF model to simulate in-stream bacteria concentrations

Next Steps

What happens next?

1. **Comment Period for Materials Presented at the TAC Meeting:**
   - **March 1, 2011 to March 31, 2011**
   - **Comments should be submitted in writing to:**
     Jennifer Carlson
     Jennifer.Carlson@deq.virginia.gov
     13901 Crown Court, Woodbridge, VA 22193

2. **Public Meetings – Time and Place TBD**

   Public Meeting for the Northern Watersheds (Fairfax County, Arlington County, Loudoun County, and the Town of Herndon)

   Public Meeting for the Southern Watersheds (Prince William County, Stafford County, and the Town of Dumfries)

***** Please send any suggestions for possible meeting locations to the contact listed above by March 8, 2011.***

Project Tasks and Milestones	January-11	February-11	March-11	April-11	May-11	June-11	July-11	August-11	September-11	October-11	November-11	December-11
Data Gathering												
Joint TAC Meeting												
First Round of Public Meetings												
Source Assessment												
Model Calibration and Validation												
Second Round of TAC Meetings												
Draft TMDL Allocations												
Third Round of TAC Meetings												
Draft TMDL Reports												
Final Round of Public Meetings												
Comment Period on Draft Report												
Final Report Submitted to EPA for Approval												

Questions?

CONTACTS

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